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Comparative analysis of lateral extensile approach and sinus tarsi approach in the surgical treatment of calcaneal fractures: A retrospective study

Two different surgical approaches in calcaneal fractures

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Abstract

Aim: Calcaneal fractures pose challenges in orthopaedic surgery due to their intricate anatomy and potential impact on the function of the feet. This study compares the outcomes of two surgical approaches, the Lateral Extensile approach (LE) and the Sinus Tarsi approach (ST) and aims to resolve the ongoing debate on optimal strategies in the management of the calcaneal fractures.

Material and Methods: We analyzed a total of 131 eligible patients. Of these, 60 patients (63 feet) underwent ST procedures, and 71 patients (74 feet) underwent LE procedures.

Results: The ST approach demonstrated significantly shorter operation times and fewer complications compared to the LE approach. Patients in the LE group had longer periods of hospital stays and prolonged union duration. The ST approach was also superior regarding postoperative talocalcaneal angle and talocalcaneal height. Postoperative AOFAS hindfoot and VAS scores were significantly better in the ST group. The mean AFOAS score was 85.6 for the ST group and 79.6 for the LE group. Complications including infections and implant-related issues were notably lower in the ST group when compared to the LE group.

Discussion: The ST approach demonstrated advantages in terms of efficiency, lower complication rates, and improved postoperative functionality which supports the idea of it being the preferred method in the management of the calcaneal fractures for appropriate cases.

Keywords

Calcaneal Fractures, Surgical Approaches, Sinus Tarsi Approach, Lateral Extensile Approach, Outcomes

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Introduction

Calcaneal fractures pose a significant challenge to the orthopaedic surgeons due to their complex anatomy and potential impact on the functioning of the foot. Various surgical approaches have been employed to repair these fractures such as two prominent techniques, Lateral Extensile (LE) approach and Sinus Tarsi (ST) approach [1]. The selection of a surgical approach for calcaneus fractures is a critical decision that involves the fracture pattern, associated injuries, soft tissue status, the surgeon's preference, and experience. The LE approach, which involves a more extensive exposure of the calcaneus, allows a more direct visualization of the fracture site for precise reduction and fixation [2]. Also, the ST approach is a more minimally invasive technique that preserves soft tissues and reduces surgical morbidity [3]. However, the choice of these approaches remains a subject of an ongoing debate within the orthopaedic community.

This retrospective study aims to compare the outcomes of these two approaches and focuses on factors such as operation times, complication rates, and overall efficacy. Our hypothesis is that the ST approach will demonstrate better results in terms of shorter operation times and fewer complication rates compared to the LE approach. This hypothesis assumes that the ST approach might reduce the postoperative complications because it is less invasive than the LE approach, moreover, fixation with headless screws in the ST approach causes less irritation than the fixation with the plate, and the need for autogenous graft use is also less in the ST approach.

Material and Methods

Patients ≥16 years of age with calcaneal fractures, operated using LE or ST approach, and patients with necessary medical records including appropriate X-rays and having at least 12 months of follow-up data were included to the study. Patients who did not have adequate medical records, any pathological or open fractures, accompanying additional lower extremity injuries, congenital lower extremity pathologies, new or previous injuries in the same extremity, underwent a previous foot surgery or had not completed 12 months of follow-up were excluded from the study.

Many clinical and radiologic parameters were evaluated. None of the patients were operated with ST approach until 2016. The ST approach was employed and preferred after this date.

Patients with fracture or displacement of the subtalar articular facet and patients with a change in Gissane and Boehler angles were more appropriate for ST incision. Patients with a previous history of foot/ankle fractures and patients with tongue-type fractures were not appropriate for this type of incision.

The skin condition is critical in patients who will especially undergo planned LE surgery and the predictive Wrinkle test is considered for these patients. Regardless of the technique used in the patient's surgery, all patients have post-op short leg brace and were followed up for 3 weeks and mobilized with support afterwards.

Lateral extensile approach

An incision is made from 5-6 cm proximal to the lateral malleolus and also between Achilles tendon and malleolus. L incision is extended to the base of the 5th metatarsal bone. The corner (aka the middle) of the incision is especially given close attention in order not to cause any postoperative wound problems. In order to obtain a flap with full thickness, the bone is reached. Calcaneofibular and talocalcaneal ligaments are separated from the bone. Peroneal tendons and sural nerve are left within the flap and are not exposed. Flap is widened upwards and subtalar joint and sinus tarsi are exposed. After that, the flap is temporarily fixated with K-wires. After the joint restoration and fixation, the site is checked for bleeding and a hemovac drain is placed. Skin saturation is provided with Allgöwer-Donati technique, and attention is paid not to cause any tightness [4].

Sinus Tarsi Approach

A 4-5 cm incision is made starting from 1 cm inferior and posterior of the tip of the lateral malleolus towards the base of the 4th metatarsal bone. Peroneal tendons and sural nerves are protected, and calcaneofibular ligament is cut to reach the joint. The subtalar joint is visible proximally and the anterior process is visible distally. In order to obtain a clear view of the subtalar joint reduction, peroneal tendons are proximally loosened and a Hintermann retractor is placed. The collapsed posterior facet fragment is corrected with the help of an elevator and reduced after the sustentaculum level is taken as a reference and temporarily fixated with K-wires. Fractures usually tend to extend to varus with the pulling power of Achilles tendon, and to fix this malposition, a transcalcaneal thick K-wire was inserted from the middle calcaneus, and varus deformity is corrected, and fixation is achieved with temporary K-wires in this position. After the subtalar joint reduction and calcaneal height are provided, first of all, 2 or 3 headless canulated screws are placed from lateral to medial and subchondral to the posterior facet. Secondly, to prevent the collapse of the posterior facet, two 5-6 mm cannulated headless screws are passed through right under the first screws from the lateral and medial of the Achilles tendon and from the posterior to the anterior of the calcaneus. Thirdly, to prevent varus deformity and to achieve the length of the calcaneus, one more 5-6 mm headless screw is placed from the calcaneal tubercle along the long axis of the calcaneus and fixation is achieved. The site is checked for bleeding, calcaneofibular ligament is repaired, and the skin layers are appropriately closed [5].

Statistical Analyses

Data were analyzed using IBM SPSS Statistics 22.0. Interobserver reliability for qualitative data was assessed with Cohen's kappa coefficient. Nonparametric variables were analyzed using the Mann-Whitney U test, and parametric variables were analyzed using the Student T-test and ANOVA. Categorical variables were compared using the Pearson chi-square test and Monte Carlo simulations with the Fisher exact test. Qualitative variables were expressed as frequencies or ratios. A P value of <0.05 was considered statistically significant..

Ethical Approval

Ethics Committee approval for the study was obtained. Umraniye Training and Research Hospital (Date: 2021-12-16, No: 00154840608).

Results

A total of 159 patients were operated on calcaneus fractures and 28 of them were found to be ineligible for inclusion to the study. Of the remaining 131 patients, 60 (63 feet) and 71 (74 feet) underwent ST approach and LE approach, respectively. The mean age, gender, trauma pattern, and other demographic characteristics of the patients were similar between groups (Table 1). Until 2016, all patients operated in our clinic were treated using LE approach and ST approach was employed after this date and was used in most cases. (Figure 1) So, the duration of the follow-up was significantly longer for patients operated with the LE approach. (Figure 2)

The mean time of the surgery was 3.1±1.1 days and 4.7±2.3 days for the ST approach and the LE approach groups, respectively. Patients in the LE group had waited for surgery longer than the ST group (p=0.001). Moreover, both postoperative and total hospital stays were longer in the LE group (Table 1). The duration of surgery was significantly longer in the LE group than in ST group, and union was achieved after a significantly longer period in LE patients when compared to ST patients (p=0.001) (Table 1).

There was good to excellent agreement between the two observers for quantitative variables with ICC values ranging from 0.78 to 0.90. Substantial to almost perfect agreement was observed for categorical variables between the two observers with κ values ranging from 0.75 to 0.96.

Preoperative Gissane angles significantly increased in the LE group (p=0.012). However, postoperative values were similar between groups (p=0.88) (Table 3). Preoperative and postoperative Boehler angles and calcaneal inclination angles measured at the last follow-up were similar between groups. Talocalcaneal angle measured at the last follow-up

Table 1. Perioperative and postoperative follow-up characteristics of the patients

	Sinus tarsi approach (n=60)				Lateral extended approach (n=71)				P*
	Mean	**±SD**	**(Min/**	**Max)**	**Mean**	**±SD**	**(Min/**	**Max)**	
Age	46,2	10,3	19	70	43,2	12,1	16	67	0,125
Duration of Surgery (mins)	74,3	13,4	45	105	99,5	14,2	65	125	0,001
	Median	**IQR**	**(Min/**	**Max)**	**Median**	**IQR**	**(Min/**	**Max)**	**P****
Follow up Duration (months)	35	23	15	72	70	27	22	120	0,001
Time to Surgery (days)	3	2	1	6	3	5	1	11	0,001
Duration of Postoperative Stay in Hospital (days)	1	1	1	2	2	2	1	16	0,001
Duration of Total Stay in Hospital (days)	5	1	2	8	8	4	3	27	0,001
Time to Union (weeks)	9	2	7	12	10	3	8	15	0,001

SD; Standart deviation,*:One Way ANOVA, ** Mann Whitney U test, Min; minimum, Max; maximum, Bold p values represent statistical significance

Table 2. Change in perioperative and postoperative anatomical and clinical measurements of calcaneus

	Sinus tarsi approach (n=63 feet)				Lateral extended approach (n=74 feet)				P*
	Mean	**±SD**	**(Min/**	**Max)**	**Mean**	**±SD**	**(Min/**	**Max)**	
Preoperative Böhler angle (°)	0,5	-27	10,5	25	3,02	-27	9,55	18	0,158
Postoperative Böhler angle (°)	21,6	7	6,9	37	20,5	-20	9,04	37	0,44
Calcaneal inclination angle (°)	21,3	14	3,6	31	20,9	10	4,57	35	0.558
Talocalcaneal angle (°)	38,8	25	4,5	47	34,1	26	3,8	44	0.001
Talocalcaneal height (mm)	79,5	68	5,4	92	76,2	62	6,45	95	0.002
Postoperative Gissane angle (°)	113,7	98	7,8	131	111,2	94	8,83	135	0,88
AOFAS hind-foot score	85,6	70	7,23	96	79,6	65	6,76	95	0,001
VAS score	1,7	0	1,78	7	3,5	0	1,85	7	0,001
	Median	**IQR**	**(Min/**	**Max)**	**Median**	**IQR**	**(Min/**	**Max)**	**P****
Preoperative Gissane angle(°)	102	24	63	146	110	23	91	130	0,012

SD; Standart deviation,*:One Way ANOVA, ** Mann Whitney U test, Min; minimum, Max; maximum, Bold p values represent statistical significance

Table 3. Comparison of the groups for revision surgery, complication and patient related outcome measures

		Sinus tarsi approach (n=60)	Lateral extended approach (n=71)	P
Implant removal	None	60 (100,0%)	61 (85,9%)	0.002
	Done	0 (0,0%)	10 (14,1%)	
Seconder surgery	None	60 (100,0%)	58 (81,7%)	0.001
	Done	0 (0,0%)	13 (18,3%)	
Deformity	None	60 (100,0%)	65 (91,5%)	0.02
	Present	0 (0,0%)	6 (8,5%)	
Complications	None	56 (93,3%)	45 (63,4%)	0.001
	Present	4 (6,7%)	26 (36,6%)	

Pearson Chi-Square

was significantly increased in the ST group (p=0.001). Also, talocalcaneal height was longer in the ST group than in LE group (p=0.02).

Mean AOFAS hindfoot scores and VAS scores were significantly better in the ST group compared to LE group (p=0.001 for both) (Table 2). The mean AOFAS score was 85.6±70 (7.23-96) and 79.6±65 (6.76-95) for the ST and LE groups, respectively.

Complications were statistically more common in the LE group than in the ST group (p=0.001). Complications occurred only in 4 (6.7%) patients in the ST group. Of these, 2 were superficial infections treated with oral antibiotics, and 1 was a Sudeck atrophy. (Figure 3) A squamous cell tumour developed in a patient at the incision site although there was no infection. However, there were 26 (36,6%) complications in the LE group. Of these, 10 were due to implant irritation symptoms. The plate failed in one patient. Three (4,2%) patients developed osteomyelitis which was treated with implant removal and several rounds of debridement. Two (2,8%) patients had superficial infections along with necrosis at the incision site that required debridement and oral antibiotic use. Four (5,6%) patients had contracture of the subtalar joint which leaded to stiffness and ongoing pain until the last follow-up (Table 3). Moreover, the need for secondary surgeries, including implant removal with permanent deformity, was significantly more common among patients operated with the LE approach when compared to patients operated with ST approach. (Table 3).

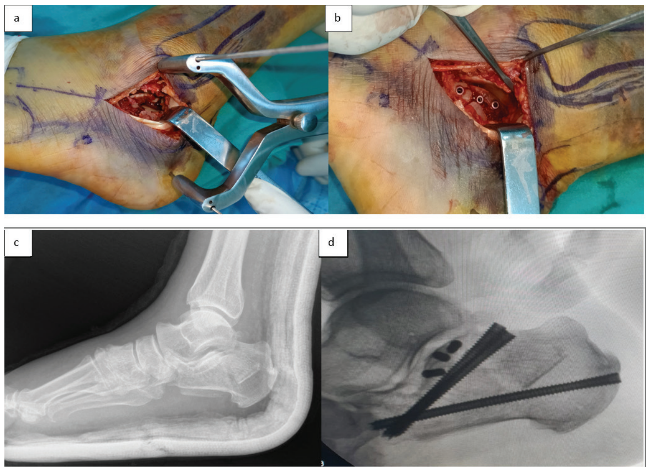

Figure 1. Perop images of a patient operated by ST approach, Preop and postop radiographs of a patient operated by ST approach a: Hintermann retractor placement and displaced joint fragment, b: After reduction and cannulated headless screw fixation, c: Preop radiographs, d: Postop scopy images

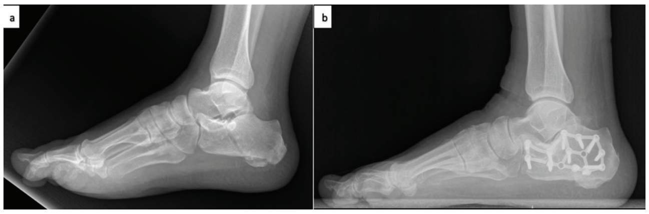

Figure 2. Patient operated with LE approach, a: Preop radiograph of the patient, b: Postop radiography

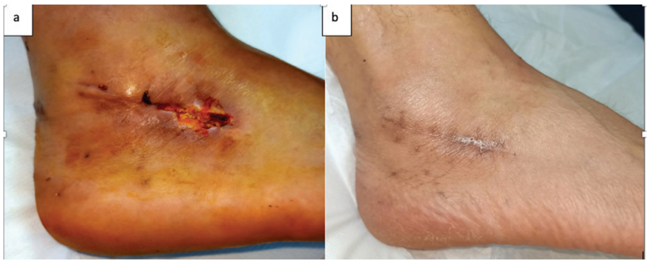

Figure 3. Patient with superficial wound site problem operated through ST approach, a: Detachment present at the incision site, b: Wound healed after oral antibiotics

Discussion

In this retrospective study, we found distinct advantages associated with each technique. The ST approach demonstrated superior results, shorter operation times, fewer complications, and enhanced postoperative functionality. Notably, this minimally invasive method exhibited a lower rate of complications including superficial infections and implant-related issues that contributed to a more favourable overall patient experience. Conversely, the LE approach was linked to prolonged operation times, increased complications, and a higher need for secondary surgeries.

Timing of surgical intervention is critical in calcaneal fractures. Wrinkle sign is a common parameter to be used in deciding on the timing of the surgery. In the literature, patients who underwent LE approach had a longer waiting time until surgery when compared to the waiting time of the patients who had ST approach. In a study by Li et al. published in 2016, time to surgery in LE group was found to be 6.9 and 4.6 days in LE and ST groups, respectively [6]. A similar study demonstrated similar outcomes [7]. In our study, we observed that the time of surgery was shorter in ST group. We believe the reason of this is because the surgeons wait longer when they are going to use LE approach due to their concern of postoperative complications.

In the literature, many articles comparing the two groups show a longer period of hospital stay for LE patients [8,9]. We also found a similar result in our study, and we believe this is because LE group is more susceptible to surgical site infection.

Operation time was significantly higher in LE group than in ST group. This leads to an increase in tourniquet application time and associated morbidities. Xie et al. found a mean operation time of 129.0 min and 108.5 min for LE and ST, respectively and indicated a significant difference between the two groups [8]. Similar results were found in another randomized controlled study carried out between 2019 and 2021 [10, 11]. According to the outcomes of our patient groups, we support the findings in the literature.

In our study, mean union time was 9 and 10 weeks for ST and LE groups, respectively, and nonunion was not observed in any patient. Park et al. did not observe any nonunion in patients they operated with ST incision for displaced intraarticular calcaneus fracture and the mean union time was 3.2 months for all patients [12].

There are various results in the literature regarding radiological parameters [13, 14]. Joseph et al. detected a significant difference between the two groups regarding Gissane and Boehler angle, calcaneal length, and width [15]. In another study, a better postop improvement was found regarding Boehler angle in LE group, but no significant difference was found regarding Gissane angle. In the same study, calcaneal height was found to be significantly higher in LE than ST, but calcaneal width and length were found to have similar results for both approaches [3]. In our study, we observed a significant difference in talocalcaneal angle and length in ST group. No difference was found between the groups regarding other radiological parameters although a significant increase was observed in both groups. In this context, we believe both approaches are generally successful and applicable.

Patients are clinically evaluated with AOFAS ankle-hindfoot score which evaluates parameters like pain, hindfoot motion, gait distance and they can also be assessed according to their VAS score which is another scale for pain evaluation. Zhang et al. found better AOFAS scores in ST patients operated for calcaneus fractures when compared to patients who underwent minimal invasive longitudinal surgery [16]. In another study, ST patients demonstrated significant improvement and difference in postoperative AOFAS and VAS scores. In another randomized controlled study carried out with 64 patients, no difference was observed in both parameters [6]. In the literature, there are also studies showing no radiological and clinical difference between the two groups [17]. Both our study and a metanalyses published in 2018 indicated that ST approach was more effective than LE approach in terms of AOFAS and VAS scores [18]. The main reason for this result is the early wound healing, earlier ankle movement and earlier confidence development observed in ST patients.

Literature data is consistent regarding the complications that may occur after both approaches. According to many articles, surgical site problems mostly occur after LE approach [6, 19]. We observed that the incidence of the incision site problems of LE patients was higher than ST patients [20, 21]. In randomized controlled studies and metanalyses comparing the two groups, surgical site problems were found to be much higher in LE group which is also consistent with the findings of our study [6, 11, 13, 14, 16, 22].

After the reunion, deformity developed in 6 (8.5%) out of 71 patients operated with LE. Zhou et al. reported varus deformity in 4 (10.8%) out of 37 patients which indicated a significant difference; however, patients did not need a revision surgery [23]. Similar to the findings in the literature, our study also reported a deformity in 6 patients which was significantly different.

While this study provides valuable insights regarding the outcomes of the LE and ST approaches for calcaneal fractures, there are several limitations. Firstly, the retrospective nature of the study introduces inherent biases and limitations associated with data collection from medical records. Selection bias may also have an influence on the results, as the choice of surgical approach was at the discretion of the operating surgeon. The relatively small sample size and single-center design restricted the generalizability of our findings. Despite these limitations, our study contributes to the ongoing discourse regarding surgical approaches for calcaneal fractures.

Conclusion

Our study revealed the distinct advantages of the ST approach over the LE method for calcaneal fractures. The aforementioned superior outcomes were shorter operation times, fewer complications, and improved postoperative functionality. These findings support a preference for the ST technique when it comes to expecting a more favorable outcome and efficiency while also ensuring the patient's well-being.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or compareable ethical standards.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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